

# Inspecting Hydrogen Installations

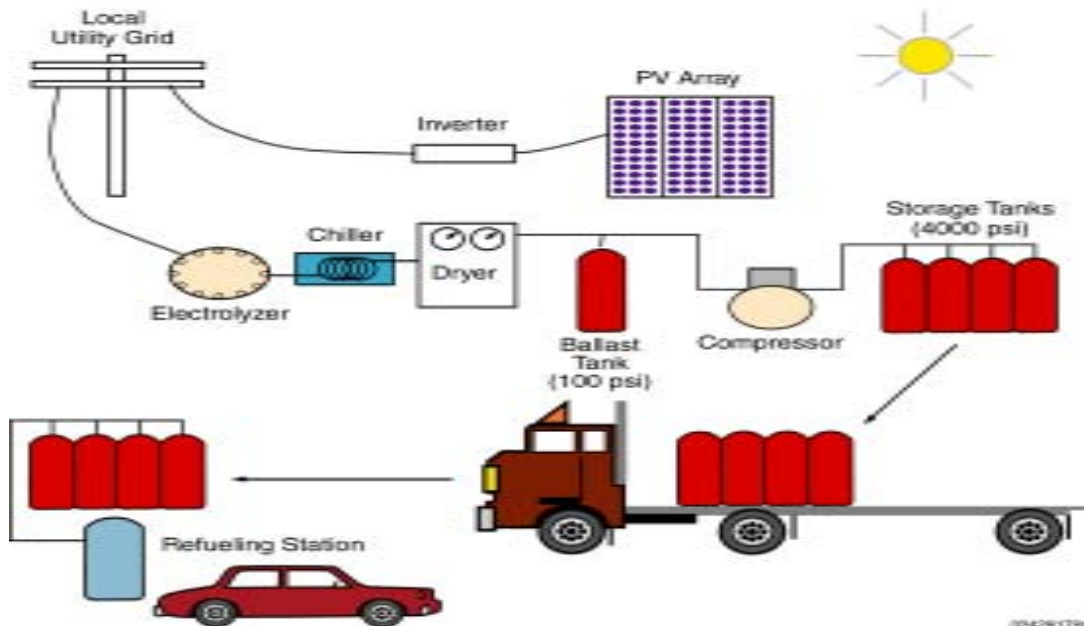
U.S. DOE DE Road Show

Karen Miller

National Hydrogen Association

# Hydrogen Fundamentals

- What is it?
- Where is it derived from?
- Why are we talking about it today?



# Properties of Hydrogen

- Btu content
- Flash point
- Vaporization
- Dispersion
- Containerization



# Hydrogen vs. Methane and Gasoline

Property	Hydrogen	Methane	Gasoline	Units
Molecular Weight	2.016	16.043	107	amu
Normal boiling point (nbp) temperature	20.268	111.632	310 to 478	K
Critical pressure	12.759	45.387	24.5 to 27	atm
Critical temperature	32.976	190.56	540 to 569	K
Density at critical point	0.0314	0.1604	0.23	g/cm <sup>3</sup>
Heat of fusion	58.23	58.47	161	J/g
Heat of vaporization	445.59	509.88	309	J/g
Heat of combustion (low)	119.93	50.02	44.5	kJ/g
Heat of combustion (high)	141.86	55.53	48	kJ/g
Energy of density	8.49	21.14	31.15	MJ/litre
NBP = Normal boiling point				
NTP – 1 atm and 20°C (293.5K)				

# Hydrogen Production Today

- Industrial systems
  - Production
  - Transport
  - Storage
  - Use



# Hydrogen and Power

- IC Engines
- Gas Turbines
- Fuel Cells



- This section is to explain that H<sub>2</sub> can and will be used as a general fuel for a variety of applications, just like gasoline or diesel or natural gas.

# Existing Standards

- Hydrogen Codes, Standards, and Regulations Matrix
  - by application
  - includes contact information
  - includes status
- NFPA



# ICC Pending Changes

- International Fire Code
- International Mechanical Code
- International Fuel Gas Code
- International Residential Code

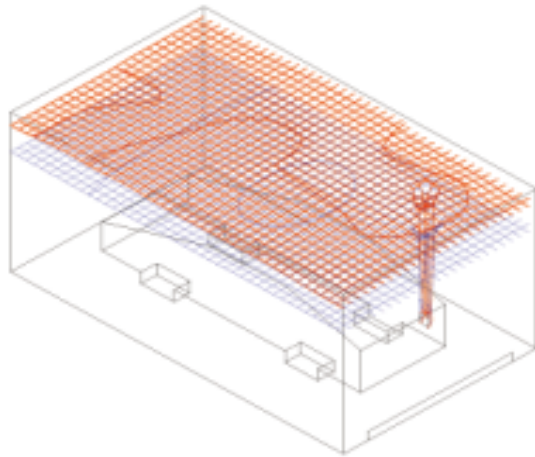


Figure C 1 - Unvented garage, 1 SCFM hydrogen leak for 20 minutes.  
Blue: 0.82% hydrogen. Red: 4.1% hydrogen

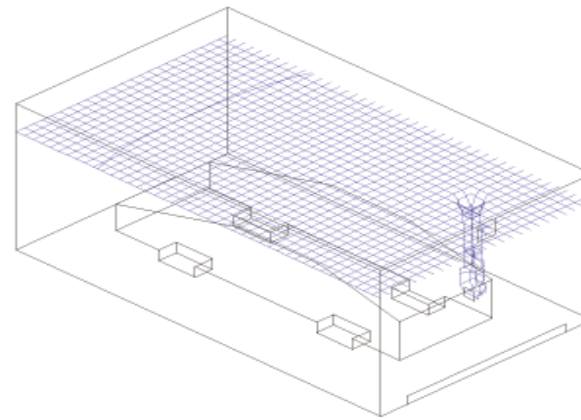
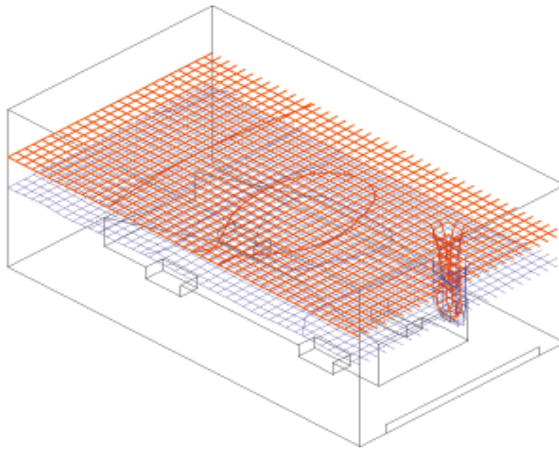


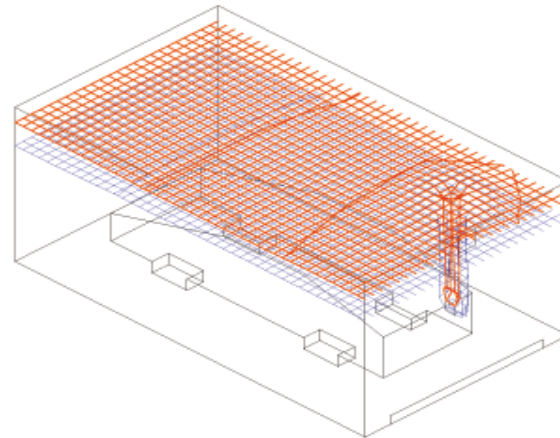
Figure C 2 - Vented garage, 1 SCFM hydrogen leak for 20 minutes.  
Blue: 0.82% hydrogen. Red: 4.1% hydrogen



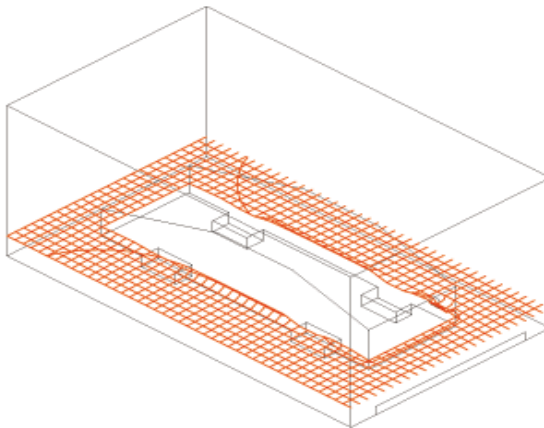
# Hydrogen Dispersion in Residential Garages Diagrams Associated with IRC, IMC, & IFGC 2002 Proposals



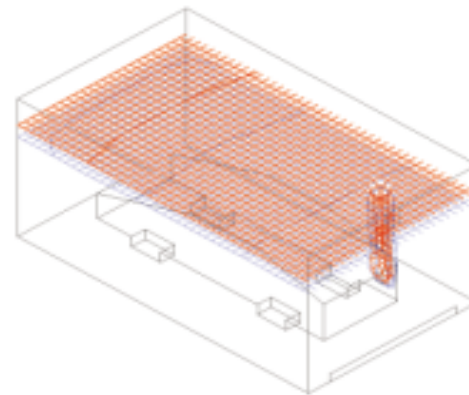
**Figure C 3 - Unvented garage, 4 SCFM hydrogen leak for 20 minutes.  
Blue: 0.82% hydrogen. Red: 4.1% hydrogen**



**Figure C 4 - Vented garage, 4 SCFM hydrogen leak for 20 minutes.  
Blue: 0.82% hydrogen. Red: 4.1% hydrogen**

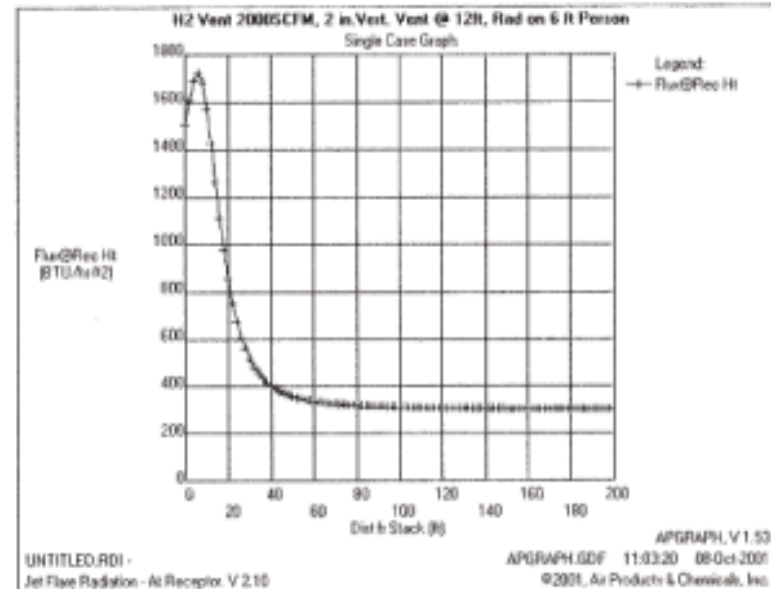
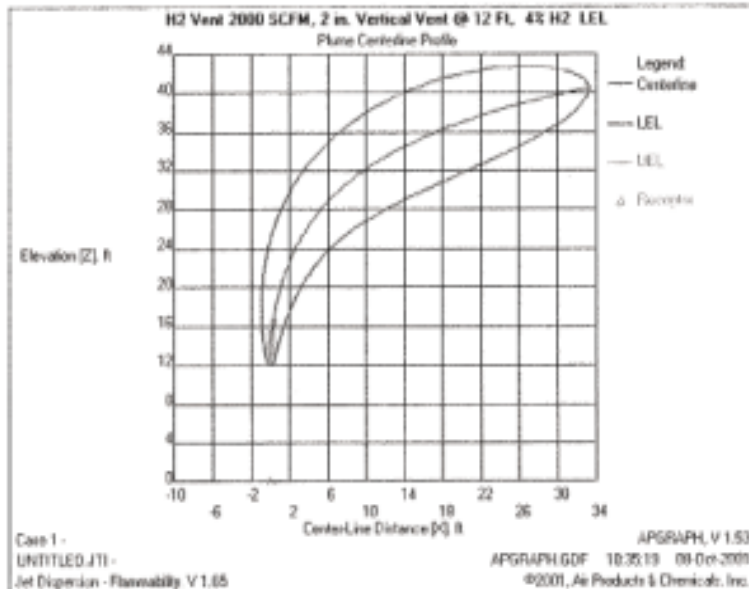
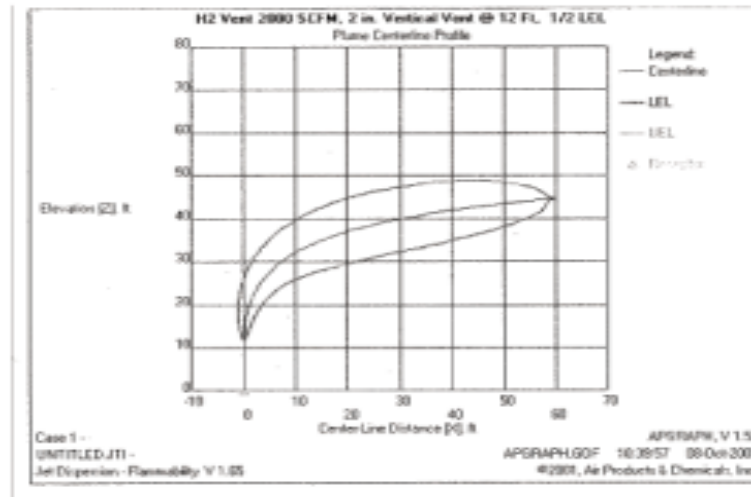


**Figure C 5 - Unvented garage, 13 SCFM hydrogen leak for 20 minutes.  
Blue: 0.82% hydrogen. Red: 4.1% hydrogen**



**Figure C 6 - Vented garage, 13 SCFM hydrogen leak for 20 minutes.  
Blue: 0.82% hydrogen. Red: 4.1% hydrogen**

# Safe-Vent Flame Radiator Diagram Associated with IFC 2002 Proposals



# Inspecting a Hydrogen Installation

- Tools Available
- The Hydrogen Handbook for Building Code and Fire Safety Officials
- The Hydrogen Sourcebook

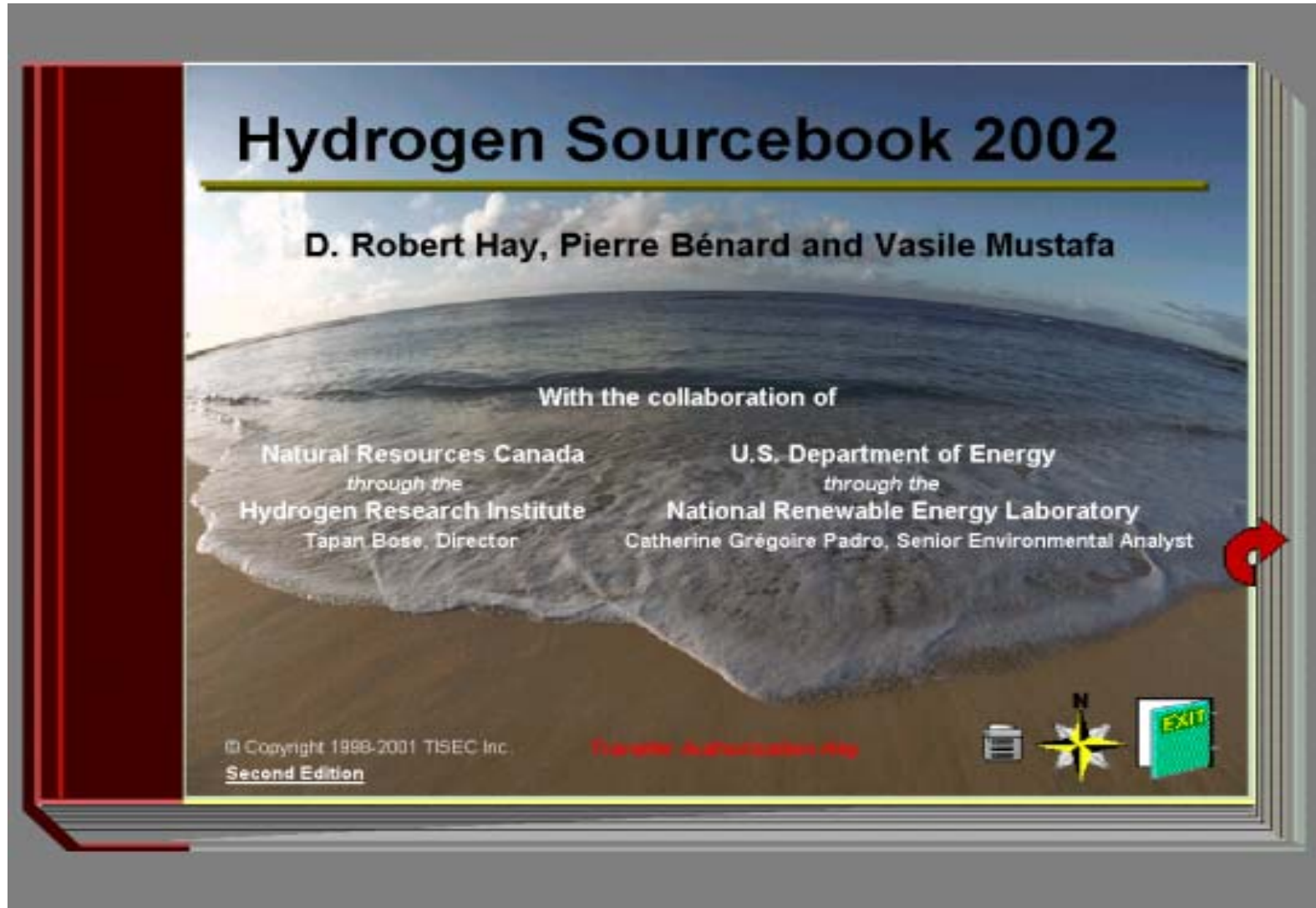


# Inspecting a Hydrogen Installation





# Inspecting a Hydrogen Installation



# Inspecting a Hydrogen Installation

- Confinement
- Review Potential for Ignition
- Minimizing Consequences
- Review the Need for Detectors
- Safety Analysis
- Review Site-Specific Factors
- Personal Investigation

# Detection

- Sensors vs. Odorants



# **For more information:**

**Karen Miller**

Vice President

The National Hydrogen Association

Tel: 202-223-5547

Email: [kmiller@ttcorp.com](mailto:kmiller@ttcorp.com)

[www.HydrogenSafety.info](http://www.HydrogenSafety.info)

[www.HydrogenUS.org](http://www.HydrogenUS.org)